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AUTHOR Hassett, Matthew J.
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ABSTRACT

A large Personalized System of Instruction (PSI) program, covering all introductory college mathematics, was established at the University of Arizona primarily because of favorable student attitude and cost effectiveness data. However, a change in evaluation questionnaire items and analysis led to an apparent change in student attitude results. The conclusion is that student attitude results should be approached cautiously by directors of PSI programs. (MP)

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Effects of Student Attitude Data on the Development of a PSI Program in Mathematics

Matthew J. Hassett
Associate Professor
Department of Mathematics
Arizona State University
Tempe, Arizona 85281
Phone 602-965-3951

For year 7/10/78 - 7/10-79
Department of Mathematics
U.S. Air Force Academy
USAFA, Colorado 80840

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Key words: student attitude, cost-effectiveness

Abstract: In this paper, we will present student attitude data taken from the results of a departmental teacher evaluation program over a number of semesters. We will show how this data was interpreted as favoring PSI courses, thus leading to the establishment of a large PSI program covering all introductory college mathematics in our university. Finally, we will show that a change in evaluation questionnaire items and analysis led to an apparent change in student attitude results. We conclude that student attitude ("teacher evaluation") results should be approached cautiously by directors of PSI programs.

Effects of student attitude data on the development of a PSI program in mathematics

Matthew J. Hassett

During the late 1960's and early 1970's, many departments on our campus began to administer student attitude questionnaires The students (and many faculty) referred to these instruments as "teacher evaluations". We are not sure that this term is appropriate. We feel that the most important evaluation of a teacher is based upon the learning that has occurred in his students. Unfortunately, no study has been done upon the relationship between our evaluation results and any direct measure of learning.

During the same time period, our department began to solve personnel problems by using individualized instruction in elementary algebra classes. Our efforts were inspired by evidence that individualized instruction at other schools led to improved learning of basic skills. However, our own PSI classes were never subjected to any comparative studies based on final examinations or follow-up course performances. Due to the great popularity of "teacher evaluations" at the time, our PSI courses were evaluated almost solely on the basis of their student attitude questionaires. In this paper, we will show how this attitude data caused administrative decision makers to support our PSI program, and to expand it to cover all pre-calculus courses in mathematics. We will also present evidence to show that use of a different evaluation form might have led to the abandonment of our PSI program. Our main purpose in

this paper is to indicate that attitude study results may vary quite a bit from one instrument to another, and that our own heavy reliance on such results without associated performance studies was very nearly a fatal mistake. Although we will present a good deal of data, none of it will be derived from controlled experiments. Our point of view will be that of the decision maker who looks at available data to make week-to-week and month-to-month decisions about course management.

Part I: Beginning the PSI Program

The problems which led to the introduction of PSI exist in many university mathematics departments. The personnel available to teach remedial courses are inexperienced teaching assistants. These assistants tend to be poor lecturers, and to avoid time-consuming but essential tasks -- homework, grading, quizzing, and interaction with students.

We learned about PSI when Prof. Fred Keller spoke at a conference at ASU in 1972. At the same time, a number of audio-tutorial programs were begun in our neighboring two year colleges, and Prof. Richard Thompson of the University of Arizona developed a PSI program in college algebra. Our observations of these programs indicated that PSI could solve many of our problems. Teaching assistants with no lecture experience could be used as tutors rather then lecturers. The PSI unit mastery testing system would impose a centrally controlled, carefully designed work structure on students and teaching assistants. When Prof. Thompson demonstrated that his PSI program in college algebra led to significant final

examination improvements over traditional methods at the University of Arizona (3), we decided to adopt a similar program for our own intermediate algebra course.

In 1973, we began our own individualized course. We did not completely understand PSI at the time, and our course was SLI (something like it). We did use student proctors in addition to our teaching assistants, and we did select materials with objectives, practice tests and immediate reinforcement exercises (2). However, our mastery requirement was expressed in terms of a semester average rather than mastery of individual units, and no re-testing was permitted. Our pacing was not flexible--tests were given once, at a scheduled day and hour. In view of our personnel problems, our SLI method was used in all sections of intermediate algebra. Our registration for the Fall of 1973 was 540.

During the first semester, a student organization sponsored a teacher evaluation program. Students responded to 14 questions for this evaluation. Responses were made on a scale ranging from 0 (least favorable) to 5 (most favorable). The sponsoring organization simply computed the mean response for each question and published a list of 14 means for each class. Although no inferential testing was done, our results were clearly better than those of other elementary mathematics classes. In Table 1, we give mean responses to two items for both SLI and traditional classes. The items were: 13. Give the instructor an overall grade. 14. Would you recommend this class for a non-major? The results are given in Table 1.

The six sections of College Algebra which were not evaluated were taught by graduate assistants, and there were official student complaints to the department chairman from each of those sections. Although the data compared different courses, departmental administrators inferred that the attitude problems in College Algebra might be ameliorated by PSI. After one more semester of similar attitude results, it was decided to restructure College Algebra as a PSI course beginning in Fall 1974.

2. Refining the PSI program. A year's experience with SLI generally leads one to re-invent PSI. This happened to us. We observed a few problems in our original system. Our inflexible quiz schedule led to severe make-up problems and student complaints -- "Can't I have just one more night to study for this test. I could do better" (He was right). Our lack of a unit mastery requirement allowed students to pass the class without mastering essential units. We took account of our failings, and adopted a more flexible pacing strategy and unit mastery testing. Thus by the Fall of 1974 we had adopted most of the basic features of PSI -- unit mastery testing, flexible pacing, reliance on printed materials and student proctors.

During the academic year 1974-5, the mathematics department voted to require all mathematics faculty to give departmental evaluations in their classes. Students responded to the items on this evaluation by rating on a scale of A

(most favorable) to E (least favorable). The questionnaire contained 18 items, 9 demographic (e.g. cumulative grade point), and 9 covering level, clarity, responsibilities, examinations, willingness to take the instructor again, intellectual maturation, evaluation of presentation and overall evaluation of the class. The PSI classes continued to fare better than comparable freshman level classes. Since the PSI class registrations were substantial (nearly 2000 students per semester), it was decided to create a separate evaluation form with slight rewording of the original items for PSI. For example, the item on willingness was stated as "Would you willingly take another class presented in this way?" for PSI students, while lecture students responded to "Would you willingly take another class from this instructor?" The final item on all evaluations was unchanged -- "Give the course an overall grade." In Table 2, we give overall responses to this final item from both PSI and lecture classes for a number of consecutive semesters.

There are a few points of interest here. First of all, the College Algebra class has received substantially improved student ratings since its conversion to PSI. Second, there is some fluctuation in PSI evaluations from semester to semester. This is due largely to fluctuations in the quality of teaching assistant personnel.

Table 2 contains only comparative statistical information. There are still some students with negative attitudes. Of the

nearly 1500 students evaluating PSI classes in the Fall of 1976, nearly 120 gave overall evaluation grades of D or E to their class experience. Of these 120 students, 10 complained to the dean about not having a "real teacher". Since 10 complaints may look like a large number to the dean, it is useful to have this comparative statistical information to show to him.

Finally, we should remind the reader that our students have no choice of method of instruction. The student who is required to take College Algebra must take a PSI class, and the student who is required to take Math for Liberal Arts must take a lecture class.

Table 2 contains information about overall evaluations. In Table 3 we give responses to other evaluation items which deal with more specific issues. We give response data for MAT 115, a PSI course in college algebra and trigonometry, and MAT 141, a lecture-recitation class in college algebra for business majors. Both courses are required -- MAT 115 for technology students and MAT 141 for business students. About 50% of the material in each course is also covered in the other.

It is clear from the first row of Table 3 that our PSI students have higher grade expectations than our lecture-recitation students. We have followed overall final exam performance carefully for a number of semesters. This performance completely justifies the high expected grade distribution. Thus we make no apologies for our grade

distribution or its possible effect on evaluations. (Joint data for determination of the correlation between expected course grade and evaluation grade was not available to us. A study now in progress suggests that this correlation is high.)

The only item in Table 3 for which PSI does not receive a substantially larger percentage of A responses is the item concerning clarity of presentation. On this item, however, our lecture-recitation class receives a substantially greater percentage of D and E responses.

By 1976, our large PSI program was running very smoothly. Administrators and most mathematics faculty were supportive. The program had become an established part of the mathematics department.

3. Keeping the PSI program. We introduced PSI in the mathematics department at Arizona State University to improve learning and attitude. We gave no thought to costs; we simply used available personnel and covered our classes. When we learned that PSI was reputed to be expensive, we compared our manpower costs to those of our lecture-recitation classes. Our lecture-recitation classes are considered by our faculty to be educationally inferior to conventional small lectures. Lecture-recitation is tolerated because it is felt to be necessary if we are to teach large numbers of students without excessive costs. Our comparison in the Fall of 1976 showed that our PSI operation was serving larger numbers of students with lower personnel costs. The data are given in Table 4.

Since that time, we have done a number of other cost comparisons. All of these comparisons favor PSI. The reason for this is obvious. Our system is staffed primarily by graduate assistants and student tutors under a few faculty supervisors; lecture-recitation requires more use of highly paid full-time faculty. Our full-time faculty do not resent this. They are not trained to do low-level remediation, and, for the most part, do not want to do it.

Faculty attitude toward our PSI program is generally favorable at present. However, our support is no longer based on favorable student evaluations. Most of our support is based on the fact that we are covering the department's remedial operation cheaply and effectively, and allowing our highly trained faculty to concentrate on the traditional college level program (starting with calculus) for which they were trained. The fact of favorable evaluations is considered to be a nice thing -- but perhaps not enough to carry our program if its costs or demands on faculty were excessive.

We were initially disappointed when faculty decided to support our program while ignoring our evaluation results. However, in the past academic year, events were to change our own point of view.

In the Fall of 1977, our student government decided to sponsor its own teacher evaluation program. This program used a form based on the Illinois Course Evaluation Questionaire (CEQ) (1). In many respects, this program was quite different

from our previous evaluation program. We list a few of these differences below. (In this list, we will refer to our own local version of the CEQ as the SAQ, and to our previous departmental form as Mathematics 1974X).

1. The response scale for SAQ was Agree Strongly, Agree, Disagree, Disagree Strongly. The scale for Mathematics 1974X was A, B, C, D, E.

2. The 21 major questions on SAQ, which were obtained from factor analytic studies, were typically less directed than questions on Mathematics 1974X. For example:
SAQ questions included

(10) The course was quite interesting

(15) This was one of my poorest courses

1974X questions included

(12) (RESPONSIBILITIES) Does the instructor make clear to you what is expected of you in this course?

(13) (EXAMINATIONS) Do the examinations reflect the assigned material?

3. Some SAQ questions were designed specifically to evaluate student response to lectures. For example:

(17) Some days I was NOT very interested in this course.

It is interesting to note now that our previous form, Mathematics 1974X, contained items which dealt with special strengths of PSI. For example, the items on responsibilities and examinations (quoted under 2 above) direct the students' attention to favorable features of behavioral instruction. No such items appeared among the 21 major questions of SAQ.

4. Analysis of Mathematics 1974X had been done in a very narrow manner within the mathematics department. All faculty were required to participate each semester. Each class was placed within a very narrow category, such as beginning calculus, for purposes of comparison with other classes. Comparisons were only done within such categories. No comparisons were made with results from other departments.

Analysis of the SAQ resulted in each class being compared to a large data base built up outside our own university. Faculty were given decile ratings for each of the 21 major items and for various combinations of items corresponding to major factors. (The highest decile was listed as 10, the lowest as 1.) These decile ratings were obtained by comparison of mathematics class results to results from a large data base containing class results from all departments at certain universities. (A special decile score was computed to compare each class to all other classes in the same subject area in the data base, but this comparison confounded all levels and subject areas in mathematics.)

Because of our highly favorable experience with evaluations, we gave this evaluation to our classes and expected superior results. We did not get them. When compared to courses in history, art and sociology, we suffered a drop in popularity. For example, on the item, "Some days I was not interested", 29% of our intermediate algebra students agreed strongly and 57% agreed. We already knew that most of our

students did not want to practice factoring problems in April. For a remedial course such as ours, the response information was no surprise. However, on the SAQ, it earned us a decile of 2. Although other item responses were not quite so low, our general factor deciles were mediocre to low. The deciles obtained by comparing our data to that of all liberal arts college courses and all mathematics courses in the norming data bank are given in Table 5.

It is easy to see that, on the SAQ, evaluations in mathematics tend to be lower than those given for the liberal arts college as a whole. In any case, our program no longer looks as if it is strongly supported by student attitude data. This is not due to any substantial change from previous semesters. Our PSI program has been run in the same manner for the previous two semesters, and with the same personnel. Unfortunately there is no longer any way of comparing our PSI courses to other mathematics courses run at the same level. Even if such a comparison were possible, it is not clear that the new set of questionaire items would favor us as the old ones did. If we had attempted to begin our program in 1977, and had based our continuation upon favorable SAQ results, that program would not have seen a second semester. Since we have had the good fortune to show our faculty results on performance tests of PSI, to do cost-effectiveness studies, and to generally reduce our old single-minded reliance upon evaluation results, we are still here.

4. Conclusions. Data from certain student attitude forms appears highly favorable to PSI, and can be used to support operation of PSI programs. However, attitude study results depend highly on the nature of (1) questionnaire items (which may implicitly favor PSI or traditional methods) and (2) statistical methodology (which may not be detailed enough to detect an advantage for one method or the other in a specific course setting). We advise all users of PSI to analyze any standard student evaluation form for possible biases. The existence of research literature which states that student attitude studies favor PSI in some circumstances does not mean that any standard attitude form will favor PSI in all circumstances.

Table 1: Mean scores for items 13 and 14 for PSI and traditional classes

ITEM 13: Overall grade for instructor

ITEM 14: Recommend for non-major.

	Intermediate Algebra (Individualized)		College Algebra (Small Lecture)		College Algebra for Business (Lecture-Recitation)	
Section	Item 13	14	13	14	13	14
1	4.52	4.62	3.47	2.31	2.73	2.31
2	4.45	4.21	4.52	4.22	3.06	2.17
3	4.60	4.34	3.31	3.20	3.20	2.37
4	4.53	3.97	3.72	2.82	4.31	3.19
5	4.57	4.39	Six sections refuse to be evaluated		3.78	2.67
6	4.40	4.51			3.85	2.54
	All sections evaluated				Three sections refuse evaluation	

Scale: 5 = most favorable

0 = least favorable

Table 2

Student response to "Give this course an overall grade" (A=most positive, E=most negative) All data represent precent of total response, and are rounded. Population sizes range from 100 to 3000. F=Fall semester, S=Spring semester.

PSI CLASSES

	Intermediate Algebra				College Algebra				College Algebra & Trig.			
	F 75	S 76	F 76	S 77	S 75	F 75	S 76	S 77	F 76	S 76	F 76	S 77
A	25	38	35	42	33	38	40	26	45	53	41	30
B	42	41	45	44	51	45	44	49	36	30	43	48
C	23	17	14	11	13	12	11	13	12	11	11	16
D	6	4	5	2	1	3	2	7	4	4	0	4
E	3	0	1	1	1	2	2	4	2	4	5	2

Lecture Classes - Same Level as PSI

	Math-Soc, Life & Management & Sci.				Math for Liberal Arts	Finite Math		
	F 75	S 76	F 76	S 77	F 75	F 75	S 73	F 76
A	12	15	14	11	18	18	17	18
B	40	40	39	39	29	34	44	56
C	27	26	28	34	30	27	27	15
D	13	13	12	12	12	18	8	7
E	7	6	6	4	12	3	4	4

Entire Department

	All PSI				All Lecture			
	F 75	S 76	F 76	S 77	F 75	S 76	F 76	S 77
A	33	41	36	36	22	24	22	23
B	42	40	43	46	41	42	40	41
C	18	15	13	12	25	22	25	24
D	5	4	5	4	8	8	9	8
E	3	1	3	2	5	4	4	3

Table 3

Comparison of MAT 141 (Lecture-Recitation) to MAT 115 (PSI) on other questionaire items: Fall 1976

Item	Course	A	B	C	D	E
Grade Expected	115	54	31	15	0	0
	141	27	32	34	7	1
Appropriate Level?	115	42	34	20	3	0
	141	24	30	20	16	10
Clarity of Presentation	115	30	27	30	10	3
	141	25	27	17	16	14
Responsibility made clear?	115	67	26	7	1	0
	141	49	25	13	8	6
Exams reflect assignments?	115	71	24	3	1	1
	141	45	27	14	7	8
Willingness*	115	51	18	16	3	12
	141	32	17	16	10	26
Intellectual Maturation	115	31	44	18	0	7
	141	14	35	31	11	10
Overall Evaluation	115	41	43	11	0	5
	141	14	39	28	12	6

*Willingness to take another course "by this method" (115) or "from this instructor" (141).

Table 4

Cost-effectiveness Data

Comparison Study, Fall 1976

Method	Lecture Recitation	PSI
Students	1134	1753
Credit Hours	4536	5612
Faculty*	10	5
Teaching Assistants**	15	7
Work Study	.067	1
Credit Help	Available	Available
Tutorial Center	NO	YES

* One course of full load

** Full T.A. load (two courses)

*** Expressed in T.A. cost units.
1 T.A. = 15 Work-study, Cost ≈ $3400.00

Table 5

SAQ decile ratings for MAT 106:

1 = low, 10 = high

Factor	College	Department
Attitude	4	6
Method	3	4
Content	4	6
Interest	2	3
Instructor	3	4
Over all	3	5

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